Space Shuttle Orbiter Digital Outer Mold Line Scanning

Charles H. Campbell[1]
NASA Johnson Space Center, Houston, Texas, 77058

Brad Wilson[2] and Mike Pavek[3]
United Space Alliance, Kennedy Space Center, Titusville, Florida 32780

and

Karen Berger[4]
NASA Langley Research Center, Hampton, Virginia, 23681

The Space Shuttle Orbiters *Discovery* and *Endeavor* have been digitally scanned to produce post-flight configuration outer mold line surfaces. Very detailed scans of the windward side of these vehicles provide resolution of the detailed tile step and gap geometry, as well as the reinforced carbon carbon nose cap and leading edges. Lower resolution scans of the upper surface provide definition of the crew cabin windows, wing upper surfaces, payload bay doors, orbital maneuvering system pods and the vertical tail. The process for acquisition of these digital scans as well as post-processing of the very large data set will be described.

I. Abstract/Summary

ORBITER Outer Mold Line (OML) surface representations were originally represented by blueprint based drawings. As a collection, these drawings represented the detailed design reference for manufacturing the vehicles. As is typical of every manufacturing process, the as built configuration will differ from the detailed design because of design tolerances, in addition to individual air frame discrepancies that accumulate over time. As part of efforts related to the Orbiter Boundary Layer Transition Flight Experiment, an activity was initiated with support from the Space Shuttle Program and the NASA Engineering and Safety Center (NESC) to develop digital OMLs for each of the three remaining Orbiters. Using capabilities currently in use by the United Space Alliance Optics Group at the NASA Kennedy Space Center, digital scans of the Discovery and Endeavor vehicles have been completed that capture more than ninety percent of the as flown vehicle definitions. The systems used to acquire these scans included a Metris MV-260 Laser Radar Scanner for acquisition of the vehicle upper surfaces, and a CogniTens Optigo 200 Photogrammetry system for acquisition of the windward tile and reinforced carbon-carbon nosecap and wing leading edges. Surface data point clouds for the windward surface of each orbiter are defined by over one billion individual Cartesian coordinates, with a resolution sufficient to define individual tile edges with a radius less than $1/10^{th}$ of an inch. This windward surface definition acquisition was enabled with the use of Optigo internal software processing at the time of scan acquisition that accomplished a screening of individual point cloud data to reduce the data volume, as well as optical capabilities that enables imaging of approximately 100 ft^2 with a single photometry system position. The upper surface scans presented challenges in acquiring complete coverage of the orbiter surfaces, due to interference issues with ground processing equipment in the Orbiter Processing Facilities as well as line of site issues that complicated Metris positioning.

[1] Aerospace Engineer, Applied Aeroscience and CFD Branch, M/C EG3, NASA Rd #1, and Associate Fellow.
[2] Aerospace Engineer, Aerothermodynamics Branch, MX 408A, 16 Victory Street, and Senior Member.
[3] Precision Measurement Engineering Lead, Optical Alignment/Field Metrology, USK-C52, 1102 John Glen Blvd.
[4] CAD/CAM TPS Manufacturing Lead, CAD/CAM Manufacturing TPS, USK-C52, 1102 John Glen Blvd.

II. Preliminary Orbiter Digital OML Surface Images

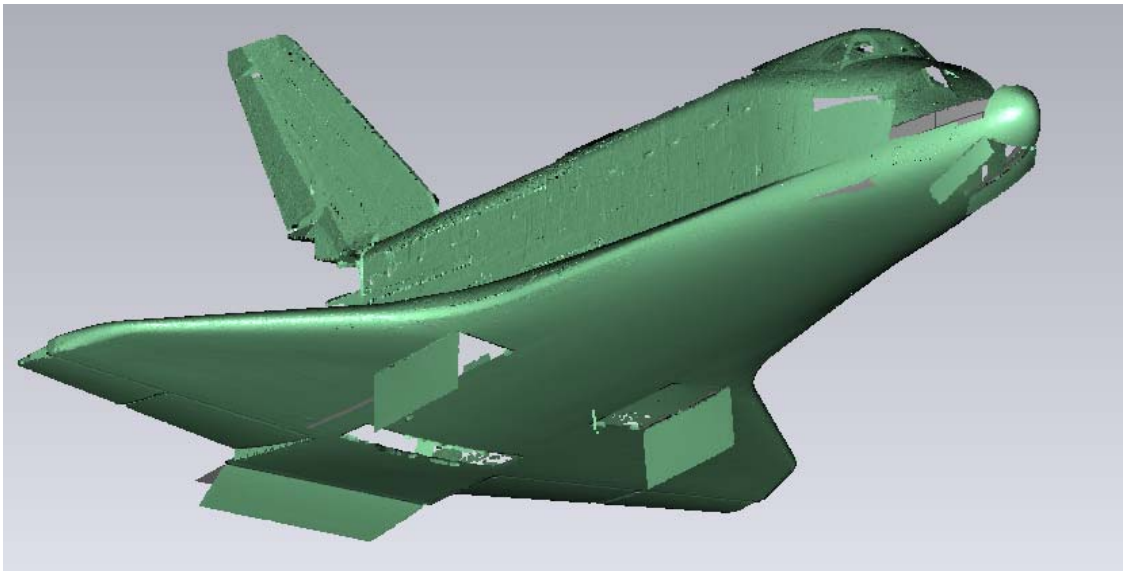

Figure 1. Digital Outer Mold Line surface isometric view of *Endeavor* with gear doors open.

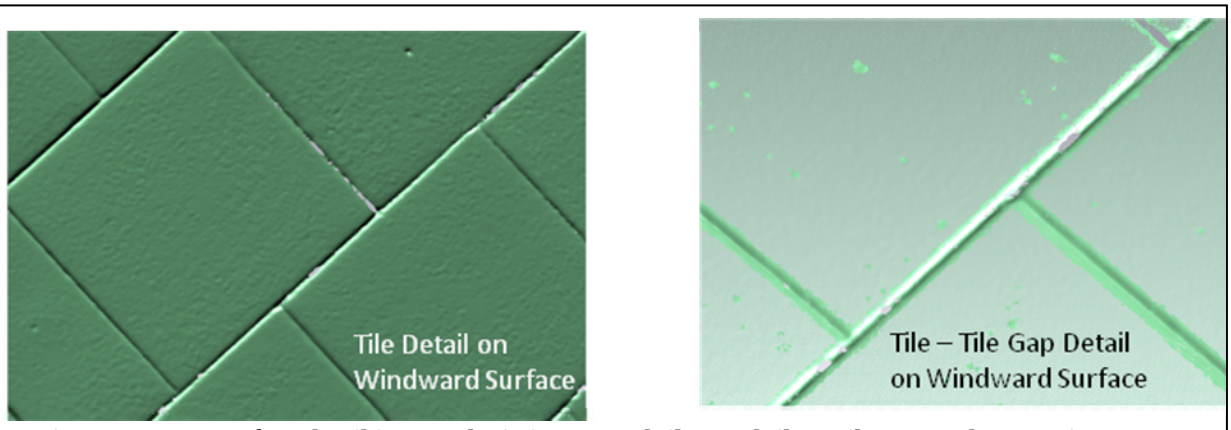

Figure 2. OML surface detail images depicting several tiles, and tile to tile step and gap region.

Acknowledgments

These activities have been the result of interactions between the Orbiter Boundary Layer Transition Flight Experiment team at United Space Alliance in Houston and Cape Canaveral, NASA personnel at Johnson Space Center and Langley Research Center and, individuals from Boeing in Houston, Cape Canaveral and Huntington Beach. Resources supporting this effort have been provided by the Space Shuttle Program, the Space Shuttle Transition and Retirement Project and the NASA Engineering & Safety Center. Complementary efforts by the Library of Congress to develop a historical reference for *Discovery* as a 'vehicle of record' have also facilitated dialogue to generate digital scans of Space Shuttle vehicle and ground processing facilities.